LUNAR IMPACT BASINS: NEW DATA FOR THE NEARSIDE NORTHERN HIGH LATITUDES AND EASTERN LIMB FROM THE SECOND GALILEO FLYBY.

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During the December 1992 Galileo Earth/Moon encounter the northern half of the nearside, the eastern limb, and parts of the western farside of the Moon were illuminated and in view, a geometry that was complementary to the first lunar encounter in December, 1990, which obtained images of the western limb and eastern farside.[1] The Galileo Solid State Imaging system[2] (SSI) obtained multispectral images for these regions during the second encounter and color ratio composite images were compiled using combinations of band ratios chosen on the basis of telescopic spectra and laboratory spectra of lunar samples.[1] Ratios of images taken at 0.41 and 0.76μm are sensitive to changes in the slope in the visible portion of the spectrum, and ratios of 0.99 and 0.76μm relate to the strength of near-infrared absorptions due to iron-rich mafic minerals (0.76/0.99 ratio) such as olivine and pyroxene. Results of the analyses of the compositional diversity of the crust[3], maria[4], and Copernican craters[5] are presented elsewhere.

Primary objectives for lunar basin analysis for the second encounter include analysis of: the north polar region and the Humboldtianum basin; the characteristics of the Imbrium basin along its northern border and the symmetry of associated deposits; the origin of light plains north of Mare Frigoris and associated with several other basins; the nature and significance of pre-basin substrate; the utilization of the stereo capability to assess subtle basin structure; the identification of previously unrecognized ancient basins; basin deposits and structure for limb and farside basins (e.g., Crisium, Marginis, Smythii, Lomonosov-Fleming); and assessment of evidence for proposed ancient basins (e.g., Procellarum). These data and results will be applied to addressing general problems of evaluation of the nature and origin of basin deposits, investigation of mode of ejecta emplacement and ejecta mixing, analysis of the origin of light plains deposits, analysis of basin deposit symmetry/asymmetry, investigation of basin depth of excavation and crustal stratigraphy, and assessment of models for basin formation and evolution. Here we discuss some preliminary results concerning lunar impact basins, their deposits, and prebasin substrates, using the same approaches that we employed for the Orientale and South Pole-Aitken basins using the data from the first encounter.[6]

The Humboldtianum basin (61N 84E; 650 km diameter; middle Nectarian) has been described as a possible double or triple impact basin[7,8], with the crater Bel'kovich as the possible inner structure or an independent crater. Humboldtianum basin deposits do not show anomalous characteristics relative to typical highlands. Galileo data distinctly show a markedly linear and angular structure of the outer (second) ring in the SE quadrant of the basin. In addition, the illumination geometry clearly highlights the radial texture of the deposits between the second and first ring, providing additional evidence that the inner ring is equivalent to the initial crater rim crest. Preliminary analyses suggests that the Bel'kovich structure is most likely a separate crater unrelated to the complex Humboldtianum western ring structure. Initial analyses show little evidence for a strong 0.76/0.99 signature for pre-mare Imbrian-aged light plains within the basin and within Bel'kovich, but many of the patches are small and will require further analysis.

The northern rim and ejecta deposits of the Imbrium basin (33N 18W; ~1200 km diameter; Lower Imbrian) are well illustrated in the Galileo SSI data. Along the northern rim the Alpes and Fra Mauro formations are generally similar to typical mature highland soils, but detailed analysis of the global mosaics is necessary to establish more specific affinities. Impact craters which have formed astride the northern part of the basin ring most likely to represent the transient crater rim crest (Plato, 101 km diameter and Iridum, 200 km diameter) display anomalously red rims. One

possible interpretation is that these deposits represent material of a different composition excavated from depth (probably deepest crust[9]).

Extensive areas to the north of Imbrium and Mare Frigoris are characterized by radial Imbrium sculpture, deposits of the Fra Mauro Formation, and Imbrian-aged light plains. Indeed, this region has one of the highest concentrations of light plains on the Moon[8]. On the basis of our initial analysis, much of the area mapped as Fra Mauro Formation and equivalent aged plains (Ip1) north of western and central Mare Frigoris show highland spectral characteristics; however, a small number of the fresh (bright-halo) craters in the plains have stronger 0.76/0.99 ratio signatures (indicative of iron-bearing minerals, but not necessarily of basalts). Thus, much of the bright plains in this region are apparently of highland composition, but there may be some mafic and possibly cryptomaria components locally. A series of younger (Orientale basin age[10]) Imbrian light plains are extensively exposed north of eastern Mare Frigoris; these have been interpreted to be thin Orientale ejecta overlying old mare materials.[7] SSI data indicate that much of the younger Ip2 plains also show typical highlands signatures, for example in the Arnold/Kane area; however, a small number of the fresh bright-halo craters have relatively more intense one-micron signatures. A dark halo crater with mare basalt affinities has been reported inside the crater Gärtner, within about 100 km of the basalts of Mare Frigoris[11]. The area in general has a mature highland soil spectral signature, and only a few hints of possible mafic fresh craters. Our analysis of the SSI data indicate that the ejecta of the dark-halo crater inside Gärtner does have a distinctly mare-like signature comparable to the medium-titanium basalts in the Imbrium interior and the younger Frigoris basalts.[12] At the present time, this is the most conclusive evidence for the presence of cryptomare deposits beneath the light plains, but it does not provide information on how widespread the deposit might be. Thus, although there is some evidence for locally more mafic material excavated by some fresh craters, and the one dark-halo crater with mare affinities, there is at present no comprehensive and extensive evidence of the presence of a cryptomaria deposit under either or both (Ip1 or Ip2) light plains deposits of the distinctiveness and extent that was observed in the Schiller-Schickard area southeast of Orientale on the first encounter.[1] This may mean that the light plains are predominantly ejecta, or that there is more extensive cryptomaria, but that: a) the ejecta is too thick here to see evidence of cryptomaria (the radial position of the dark halo crater in Gärtner is closer to the rim of the larger Imbrium basin than that of the Schiller-Schickard deposits to the smaller Orientale), b) the cryptomaria are in tiny patches only and so we see only a few impact craters with a more mafic signature, c) we are dealing with a "non-traditional" cryptomare[13] (basalt with non-distinct 1μm band depth similar to some western limb basalts seen in the first encounter [14]), d) the Ip2 are post-Imbrium lavas with a veneer of later ejecta, and/or e) we are dealing with a different type of lava (non-mare basalt, and relatively high albedo).

Earth-based spectra show an olivine-bearing fresh crater ejecta deposit on the northeastern rim of the Crisium basin[15] (17.5N 58.5E; 1060 km diameter; Nectarian); this crater is observed in the SSI data, but so far we see no evidence for an extensive deposit of similar composition on the north rim or elsewhere on the basin rim. We are presently analyzing data for the eastern limb highland basins such as Marginis basin (20N 84E; 580 km diameter; pre-Nectarian), Smythii basin (840 km diameter; pre-Nectarian) and Lomonosov-Fleming basin (19N 105E; 620 km diameter; pre-Nectarian).

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